V. REMARKS

Claims 1-6, 8-14 and 16 are rejected under 35 U.S.C. 103(a) as unpatentable over Choo et al. (U.S. Patent No. 6,407,360) in view of Opower (U.S. Patent No. 5,513,195) and in view of Beyer et al. (U.S. Patent No. 5,705,788). The rejection is respectfully traversed.

As an introduction, the claims now recite that the laser output is controlled based on the light intensity distribution of the composite laser light transmitted through the brittle material. This feature is specifically supported by the following descriptions (A) and (B).

(A) If the light intensity distribution of the composite laser light transmitted through the brittle material is greater than necessary, the laser output is reduced (see amended claim 1, and also page 9, line 29 to page 10, line 6 the specification)

(B) Since the beam strength is variable under control, if the light intensity distribution of the composite laser light transmitted through the brittle material is insufficient, the laser output is increased so as to ensure a composite light intensity distribution enough for the cutting work (see page 10, line 7 to page 11, line 12 of the specification).

Choo discloses a laser cutter including a laser unit, a groove cutting device, a cooling unit and a coolant inhaler. The laser unit irradiates a laser beam with a specific wavelength along a cutting line of a target object being cut. The groove cutting device forms a pre-cut groove at a selected portion of the cutting line. The cooling unit supplies a coolant to the target object along the cutting line on which the laser beam has been irradiated. The coolant inhaler inhales a coolant supplied to the target object. The groove cutting device includes a first, a second rod and a rotating blade. The first rod is disposed in front of traveling direction of the laser unit. The second rod is pivotally coupled to the first rod with the second rod rotating clockwise or counterclockwise. The rotating blade is coupled to one-sided end of the second rod for forming a pre-cut groove at a selected portion of the cutting line of the object being cut.

Opower teaches a semiconductor laser system that includes a plurality of semiconductor laser units for outputting laser radiation. Each of the laser units has a laser oscillator. The laser radiation output from each laser unit is coupled with low loss

to a first end of one single mode light conduction fiber associated with the respective laser unit for guiding the laser radiation output from the laser unit to a second end remote from the first end. A fiber bundle is formed from the light conducting fibers of the plurality of laser units. An end of the fiber bundle is formed by the second ends of the light conducting fibers. The end of the fiber bundle outputs a combined laser radiation that is substantially the sum of the laser radiation output from each of the second ends. A phase control device independently controls the phase of the laser radiation output from at a least several of the laser units contributing to the combined laser radiation to establish desired phase relationships between different ones of the laser units. The combined laser radiation output from the end of the fiber bundle includes a superposition of the radiation from the laser units that takes place at a predeterminable phase orientation established by the phase control device.

Beyer teaches a process for material treatment with diode radiation. A plurality of diodes emit diode radiation and directs the emitted radiation upon a treatment region of a workpiece. An intensity distribution of a radiation profile of the radiation directed upon the region is varied by controlling an output power of at least some of the diodes. A monitoring a temperature distribution of the treatment region produced by radiation from the diodes during irradiation thereof is monitored. The variation of the intensity distribution is controlled in accordance with results of the monitoring.

Claim 1, as amended, is directed to a method for cutting brittle material by irradiating laser light from a laser light source onto a brittle material to generate thermal distortions over a wide range of the brittle material, providing cracks in the interior of the brittle material and moving that irradiating position along a predetermined line of the brittle material to cut the brittle material with the brittle material having a front face surface and an opposite rear face surface. Claim 1 recites that the method includes:

providing a plurality of optical fibers which guide laser lights from a plurality of laser light sources to the brittle material;

driving the plurality of laser light sources, with the plurality of optical fibers in a bundled condition such that irradiating spots of the lights irradiating the brittle material are arranged in a matrix arrangement, for irradiating a composite laser light at a

selected composite laser light intensity which achieves a predetermined shape onto the front face surface of the brittle material being irradiated;

measuring a light intensity distribution of the composite laser light on the irradiated front face surface of the brittle material;

measuring a light intensity of the composite laser light transmitted through the brittle material to the rear face surface of the brittle material; and

in response to measuring the light intensity distribution, adjusting the light intensity distribution of this composite laser light by controlling respectively the light intensity of the plurality of the laser light sources and, if the light intensity on the rear face surface of the brittle material is not appropriate, controlling the selected composite laser light intensity.

Claim 9, as amended, is directed to a method for cleaving brittle material wherein thermal distortions are generated over a wide range of the brittle material by irradiating laser light from a laser light source onto a brittle material and a crack formed at a starting point of processing the brittle material is advanced by moving that irradiating position along a predetermined line of the brittle material to cleave the brittle material with the brittle material having a front face surface and an opposite rear face surface. Claim 9 recites that the method includes:

providing a plurality of optical fibers which guide laser lights from a plurality of laser light sources to the brittle material;

driving the plurality of laser light sources, with the plurality of optical fibers in a bundled condition such that irradiating spots of the laser lights irradiating a surface of the brittle material are arranged in a matrix arrangement, for irradiating a composite laser light at a selected composite laser light intensity which achieves a predetermined shape onto the front face surface of the brittle material;

measuring a light intensity distribution of the composite laser light on the irradiated surface of the brittle material;

measuring a light intensity of the composite laser light transmitted through the brittle material to the rear face surface of the brittle material; and

in response to measuring the light intensity distribution, adjusting the light intensity distribution of this composite laser light by controlling respectively the light

intensity of the plurality of the laser light sources and, if the light intensity on the rear face surface of the brittle material is not appropriate, controlling the selected composite laser light intensity.

It is respectfully submitted that none of the applied art, alone or in combination, teaches or suggests the features of claims 1 and 9 as amended. Specifically, it is respectfully submitted that none of the applied art, alone or in combination, teaches or suggests measuring a light intensity distribution of the composite laser light on the irradiated surface of the brittle material and measuring a light intensity of the composite laser light transmitted through the brittle material to the rear face surface of the brittle material such that, in response to measuring the light intensity distribution, adjusting the light intensity distribution of this composite laser light by controlling respectively the light intensity of the plurality of the laser light sources and, if the light intensity on the rear face surface of the brittle material is not appropriate, controlling the selected composite laser light intensity. Thus, it is respectfully submitted that one of ordinary skill in the art would not be motivated to combine the features of the applied art because such combination would not result in the claimed invention. As a result, it is respectfully submitted that claims 1 and 9 are allowable over the applied art.

Claim 6, as amended, is directed to an apparatus for cutting brittle material by irradiating a brittle material with a laser light from a laser light source and moving that irradiating position along a predetermined line of the brittle material that includes a first light intensity measuring means for measuring a light intensity distribution of the composite laser light on an irradiated surface of the brittle material and a second light intensity measuring means for measuring a light intensity of the composite laser light transmitted through the brittle material onto a surface disposed opposite the irradiated surface. Claim 6 recites that a composite laser light which has a predetermined shape is irradiated onto the surface of the brittle material with a plurality of bundled optical fibers, the light intensity distribution of this composite laser light is adjusted by controlling respectively the light intensity of the plurality of laser light sources in response to the measured light intensity distribution of the composite laser light and, if the light intensity transmitted to the surface of the brittle material opposite the irradiated surface is not appropriate, the light intensity of the composite laser light is controlled.

Claim 14, as amended, is directed to an apparatus for cleaving brittle material by irradiating the brittle material with a laser light from a laser light source and moving that irradiating position along a predetermined line of the brittle material that includes a first light intensity measuring means for measuring a light intensity distribution of the composite laser light on an irradiated surface of the brittle material and a second light intensity measuring means for measuring a light intensity of the composite laser light transmitted through the brittle material onto a surface disposed opposite the irradiated surface. Claim 14 recites that a composite laser light which has a predetermined shape is irradiated onto the surface of the brittle material with a plurality of bundled optical fibers, and the light intensity distribution of this composite laser light is adjusted by controlling respectively the light intensity of the plurality of laser light sources in response to the measured light intensity distribution of the composite laser light and, if the light intensity transmitted to the surface of the brittle material opposite the irradiated surface is not appropriate, the light intensity of the composite laser light is controlled.

It is respectfully submitted that none of the applied art, alone or in combination, teaches or suggests the features of claims 6 and 14 as amended. Specifically, it is respectfully submitted that none of the applied art, alone or in combination, teaches or suggests a first light intensity measuring means for measuring a light intensity distribution of the composite laser light on an irradiated surface of the brittle material and a second light intensity measuring means for measuring a light intensity of the composite laser light transmitted through the brittle material onto a surface disposed opposite the irradiated surface. Further, it is respectfully submitted that none of the applied art, alone or in combination, teaches or suggests that, if the light intensity transmitted to the surface of the brittle material opposite the irradiated surface is not appropriate, the light intensity of the composite laser light is controlled. Thus, it is respectfully submitted that one of ordinary skill in the art would not be motivated to combine the features of the applied art because such combination would not result in the claimed invention. As a result, it is respectfully submitted that claims 6 and 14 is allowable over the applied art.

Claims 2-5 depend from claim 1 and include all of the features of claim 1. Thus, it is respectfully submitted that the dependent claims are allowable at least for the reason claim 1 is allowable as well as for the features they recite.

Claim 8 depends from claim 6 and includes all of the features of claim 6. Thus, it is respectfully submitted that claim 8 is allowable at least for the reason claim 6 is allowable as well as for the features it recites.

Claims 10-13 depend from claim 9 and include all of the features of claim 9. Thus, it is respectfully submitted that the dependent claims are allowable at least for the reason claim 9 is allowable as well as for the features they recite.

Claim 16 depends from claim 14 and includes all of the features of claim 14. Thus, it is respectfully submitted that claim 16 is allowable at least for the reason claim 14 is allowable as well as for the features it recites.

Claims 17-20 are rejected under 35 U.S.C. 103(a) as unpatentable over Choo in view of Opower and in view of Beyer. Claims 17-20 are canceled and therefore the rejection as applied thereto is now moot. Withdrawal of the rejection is respectfully requested.

Withdrawal of the rejection is respectfully requested.

Claims 6, 8, 14 and 16 are rejected under 35 U.S.C. 103(a) as unpatentable over Jurgensen (U.S. Patent No. 6,888,853) in view of Mueller et al (U.S. Patent No. 6,086,366) in further in view of Das et al. (U.S. Patent Application Publication No. 20030074096). The rejection is respectfully traversed.

Jurgensen teaches an improved laser radiation source for processing materials as well as an arrangement for processing materials having a laser radiation source and the operation. An extremely high power density and energy are achieved in a cost-beneficial way and both the beam shape with respect to flexibility, precision and beam positioning as well as the beam power can be exactly controlled even given significantly higher laser powers. A system and method are provided for selectively processing material on a processing surface of a printing form to create a fine structure or pattern for images or text. At least one fiber laser includes a pump source and a laser fiber. A laser gun is mounted adjacent the printing form and has at least a focusing optics. The fiber laser outputs a laser beam which is diffraction-limited to permit the focusing optics

to focus the laser beam onto the processing surface of the printing form as a spot having a spot size sufficiently small to process the processing surface to create the fine structure or pattern for images or text.

Mueller discloses a device for removing material from a workpiece that includes a laser for irradiating the workpiece in a locally-limited ablation region for removing material. A handle part that receives the laser, positions a laser beam in the ablation region. The handle part has a distance-measuring device for controlling the depth of the material removal. The distance-measuring device employs the laser that serves in material removal to generate a measurement beam for measuring the distance between the workpiece surface in the ablation region and a reference point during the material removal. The reference point is in a fixed position relationship relative to the handle part.

Das discloses a selective laser sintering method for producing a heterogenous product in which a model of the heterogenous product is generated using a computer. The model is processed using an electronic processing device to obtain a plurality of cross-sectional layer representations of the model. The method includes the steps of positioning an array of delivery nozzles adjacent to a material deposition bed; filling each of the nozzles with at least one of a plurality of different materials with the materials differing in at least one of composition and deposition properties; and directing the nozzles to various positions relative to the deposition bed and disposing the materials upon the deposition bed at the various positions to form each of the plurality of cross-sectional layer representations of the model.

It is respectfully submitted that none of the applied art, alone or in combination, teaches or suggests the features of claims 6 and 14 as amended and as discussed above. Thus, it is respectfully submitted that one of ordinary skill in the art would not be motivated to combine the features of the applied art because such combination would not result in the claimed invention. As a result, it is respectfully submitted that claims 6 and 14 are allowable over the applied art.

Claim 8 depends from claim 6 and includes all of the features of claim 6. Claim 16 depends from claim 14 and includes all of the features of claim 14. Thus, it is

respectfully submitted that the dependent claims are allowable at least for the reasons the independent claims are allowable as well as for the features they recite.

Withdrawal of the rejection is respectfully requested.

Claims 1-5, 9-13, 19 and 20 are rejected under 35 U.S.C. 103(a) as unpatentable over Japan 410034364 in view of either Japan 2001228449 and further in view of Das. The rejection is respectfully traversed.

Japan 410034364 teaches a brittle material splitting method by plural point heat sources. A crack formed in a starting point of a material is guided with thermal stress by irradiation generated by a laser beam along a predetermined split line. Plural heat sources have respectively different diameters from each other which are simultaneously applied to a position being a forward end of the crack on the predetermined split line. The temperature distribution has aced the grade in the vicinity of the crack and Annie is alarmed without raising the power density of the laser beam.

Japan 2001228449 teaches a laser beam condensing unit and a laser beam machining device. A laser beam is emitted from a plurality of light sources and is condensed so as to have a high energy density at a small spot.

As discussed above, claims 1 and 9 are allowable over Choo, Opower and Beyer. Neither Japan 410034364, Japan 2001228449 or Das, alone or in combination, cure the deficiencies of Choo, Opower and Beyer. Thus, we propose to argue that claims 1 and 9 are allowable over the combination of all of these references.

Claims 2-5 depend from claim 1 and include all of the features of claim 1. Thus, it is respectfully submitted that the dependent claims are allowable at least for the reason claim 1 is allowable as well as for the features they recite.

Claims 10-13 depend from claim 9 and include all of the features of claim 9. Thus, it is respectfully submitted that the dependent claims are allowable at least for the reason claim 9 is allowable as well as for the features they recite.

Claims 19 and 20 are canceled and therefore the rejection as applied thereto is now moot.

Withdrawal of the rejection is respectfully requested.

Newly-added claims 21 -24 also include features not shown in the applied art.

The present invention has a distinctive feature as described in page 12, lines 18-30 of the specification. As yet another feature, the present invention is applicable to the case of cutting a brittle material into a curved or circular shape by effecting laser irradiation on the surface of the brittle material along the curvilinear or circular shape.

According to the present invention, a wide area at the surface of the brittle material can be irradiated with a laser beam having a shape required for processing. As a result, it is possible to heat a large volume of the internal portion of the brittle material simultaneously, thereby increasing the process speed (page 6, lines 12-16 of the specification).

In practice, the optimum beam shape is set in accordance with the optimum light intensity distribution shape which is anticipated according to the conditions of the object to be processed (glass quality, thickness and the like), based on a stress analysis and a temperature distribution analysis of thermal conduction which are done in advance by a computer. Based on the thus set optimum beam shape, the number, light intensity and arrangement of each light source are suitably determined, and then irradiation on the material is performed (page 12, lines 5-11 of the specification).

For the setting of the beam shape, attention should be paid to the process speed in terms of productivity and also to the cutting accuracy in terms of sectional quality at the cut surface. Speaking generally and simply, a beam having a narrower vertical width and a longer horizontal width is effective for speed and accuracy (page 12, lines 2-4 of the specification).

Although actual optimization of the beam shape requires a complex process, the main issue of the present invention is not optimization of the beam shape but to provide a lens-free optical system which enables simple change of the beam shape. Conventionally, the beam shape is set by the optical system using optical elements such as special lenses or diffraction gratings. On the other hand, the present invention has an advantage of achieving a desired beam shape by changing either locations of the optical fibers or an output from each laser source, which is easier than the conventional process.

Specifically, new claim 21 is directed to a method wherein the spots are aligned a1i in a straight line on the surface of the brittle material and caused to emit a laser light

successively from one end of the surface to the other, thereby heating the surface of the brittle material. New claim 22 is directed to a method wherein the spots are moved on the surface of the brittle material along a curvilinear or circular shape, thereby forming a crack and cutting out the brittle material into the curvilinear or circular shape. Also, apparatus claims are added to correspond to these method claims.

In view of the foregoing, reconsideration of the application and allowance of the pending claims are respectfully requested. Should the Examiner believe anything further is desirable in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicants' representative at the telephone number listed below.

Should additional fees be necessary in connection with the filing of this paper or if a Petition for Extension of Time is required for timely acceptance of the same, the Commissioner is hereby authorized to charge Deposit Account No. 18-0013 for any such fees and Applicant(s) hereby petition for such extension of time.

Respectfully submitted,

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